

# Assessment of Commercial Suborbital Market



Presentation to the NASA Advisory Council's  
Commercial Space Committee (NAC CSC)

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# Agenda

- ✦ Overview (What is an SRV?)
- ✦ Forecast Approach
- ✦ Demand by Market
- ✦ Integrated Demand Forecast



# Overview



- ✦ Suborbital reusable vehicles (SRVs) are creating a new spaceflight industry
- ✦ This project forecasts demand for SRVs
  - ✦ Informs government and industry decision makers
  - ✦ Analyzes market dynamics
  - ✦ Identifies actionable drivers of growth
- ✦ Project jointly funded by FAA and Space Florida and conducted by The Tauri Group



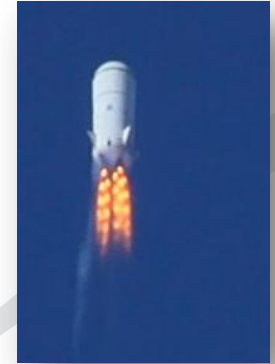
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# What is a Suborbital Reusable Vehicle (SRV)?

- ✦ Vehicle typically crosses the threshold of space (~100km/ ~62 mi)
- ✦ Reusable
- ✦ 1 to 5 minutes of microgravity
- ✦ Currently planned vehicles
  - ✦ Up to ~700 kg of cargo
  - ✦ Some carry people
    - ✦ Current ticket prices \$95k to \$200k
    - ✦ Between 1 and 6 passengers
  - ✦ May launch very small satellites



**Armadillo Aerospace:  
STIG and Hyperion**



**Blue Origin:  
New Shepard**



**UP Aerospace:  
SpaceLoft XL**



**Virgin Galactic:  
SpaceShipTwo**

**XCOR: Lynx**



**Masten Space  
Systems: Xaero  
and Xogdor**



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# SRV Capabilities and Prices

Company	SRV	Seats*	Locker Equivalents (estimated)	Cargo (kg)	Price	Announced Operational Date
UP Aerospace	SpaceLoft XL	--	0.5	36	\$350k per launch	2006 (actual)
Armadillo Aerospace	STIG A	--	1	10**	Not announced	2012
	STIG B	--	2	50**	Not announced	2013
	Hyperion	2	12	200**	\$102k per seat	2014
XCOR Aerospace	Lynx Mark I	1	3	120	\$95k per seat	2013
	Lynx Mark II	1	3	120	\$95k per seat	2013
	Lynx Mark III	1	28	770	\$95k per seat; \$500k for small sat launch	2017
Virgin Galactic	SpaceShipTwo	6	36	600	\$200k per seat	2013
Masten Space Systems	Xaero	--	4	25	Not announced	2012
	Xogdor					2013
Blue Origin	New Shepard	3+	5	120**	Not announced	Not announced

\* Passengers only; several vehicles are piloted

\*\*Net of payload infrastructure

# Forecast Approach

- Analysis of plans for SRVs
- Interviews with vehicle developers
- Independent of SRV provider proprietary data

## Research, Interviews, Survey

- 120 interviews with users and experts
- Survey of 226 wealthy individuals
- Detailed research of markets

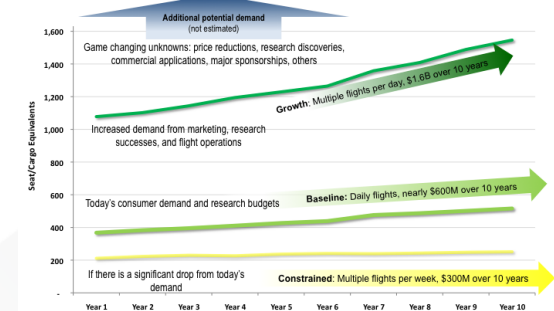
- Scenario-based forecast focused on quantifying predictable demand
- Identify uncertainties



**SRV  
Supply**



**Market  
Dynamics**



**Demand  
Forecast**



# Purpose of the Forecast

- ✦ The primary purpose of this forecast is to provide a comprehensive analysis of what is known about the SRV industry
  - ✦ Who the players are
  - ✦ Current activities and plans
  - ✦ Trends, market dynamics, and areas of uncertainty
- ✦ Provides a broader focus on market dynamics, rather than a point estimate of the future
- ✦ In a new market or industry, many unpredictable and sometimes unknown factors will shape outcomes
- ✦ We have focused on:
  - ✦ Aggregating, analyzing, and resolving information about future demand
  - ✦ Identifying uncertainties and areas where increased awareness of SRVs could affect the future

# Demand by Market



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# SRV Markets

## COMMERCIAL HUMAN SPACEFLIGHT

Human spaceflight experiences for tourism or training

## BASIC AND APPLIED RESEARCH

Basic and applied research in a number of disciplines, leveraging the unique properties of and access to the space environment and microgravity

## AEROSPACE TECHNOLOGY TEST AND DEMONSTRATION

Aerospace engineering to advance technology maturity or achieve space demonstration, qualification, or certification

## MEDIA AND PUBLIC RELATIONS

Using space to promote products, increase brand awareness, or film space-related content

## EDUCATION

Providing opportunities to K-12 schools, colleges, universities, and graduate programs to increase access to and awareness of space

## SATELLITE DEPLOYMENT

The use of SRVs to launch small payloads into orbit

## REMOTE SENSING

Acquisition of imagery of the Earth and Earth systems for commercial, civil government, or military applications

## POINT-TO-POINT TRANSPORTATION

Future transportation of cargo or humans between different locations

# Scenario Definitions

- ✦ **Baseline Scenario:** SRVs operate in a predictable political and economic environment that is relatively similar to today's. Existing trends generate demand
- ✦ **Growth Scenario:** New dynamics emerge from marketing, branding, and research successes
  - ✦ Commercial human spaceflight has a transformative effect on consumer behavior, and more consumers purchase SRV flights
  - ✦ SRV research results attract significant new government, international, and commercial interest
- ✦ **Constrained Scenario:** Dramatic reductions in spending compared to today, due, for example, to worsened global economy
- ✦ All scenarios:
  - ✦ Prices remain at current levels
  - ✦ Perception of safe operations
  - ✦ Year 1 = start of regular SRV operations



# Commercial Human Spaceflight

## Commercial Human Spaceflight

*Human spaceflight experiences for tourism or training*

- ✦ Forecast predicts 8,000 individuals interested, willing, and able to pay for a suborbital flight
  - ✦ 95% high net worth (\$5M+), 5% space enthusiasts (lower net worth)
  - ✦ About 40% (3,600) will fly over the next 10 years
  - ✦ Growth scenario projects over 24,000 individuals
- ✦ Based on survey results reflecting strong interest and realistic ability and willingness to pay
- ✦ Forecast sensitive to several assumptions that would change projection
- ✦ Corporate sales, contests and promotions, and in-space training demand totals 56 seats over 10 years (baseline), 74 (growth)

# How We Estimated Demand for Individuals

COMMERCIAL HUMAN SPACEFLIGHT

Individuals

Corporate

Contests and promotions

In-space personnel training

- ✦ Survey of 226 US individuals with greater than \$5M in investable assets
  - ✦ Because survey results on hypothetical spending overstate willingness to purchase, used multiple questions to validate interest and likelihood of purchase
  - ✦ Based on survey, only 4% of high net worth individuals have ever spent \$100K per person on leisure trip or experience
- ✦ Interest in suborbital flight
  - ✦ Extremely or very interested in taking a suborbital trip
  - ✦ Likely to purchase a suborbital trip (alone or in addition to other spaceflight options)
  - ✦ Willingness to pay \$100K or more for a suborbital trip
  - ✦ Ranked a suborbital trip highly compared to other options
- ✦ Performed cross checks on total population determining likelihood of purchase
  - ✦ How much imagine spending (per person) on a once in a lifetime trip (\$100K threshold)
  - ✦ Most ever actually spent (per person) on a past trip (\$50K threshold in baseline)
- ✦ Predicted demand based on survey results applied to global population with \$5M+ net worth (~3,000,000)
- ✦ Additional 5% to account for demand from individuals with lower net worth
- ✦ Estimated likelihood of flying in any given year based on 25 years per individual
- ✦ Growth scenario relaxed past spending requirement, constrained scenario increased requirement



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# Current Reservations for SRVs

- ✦ Four SRVs capable of carrying humans in development
- ✦ Announced prices range from \$95K to \$200K
- ✦ 925 reservations to date for SRV flights
  - ✦ Celebrity passengers include Stephen Hawking, Ashton Kutcher
  - ✦ At least 1 family has purchased an entire flight for \$1M
  - ✦ For Virgin Galactic, 35-40% of passengers from US, 15% UK, 15% Asia-Pacific

## SRV reservations to date

Company	System	Planned start	Reservations
Armadillo	Hyperion	2014	200
Blue Origin	New Shepard	TBD	No info
Virgin Galactic	SpaceShipTwo	2013	550
XCOR	Lynx Mark II	2013	175
Total reservations			925

- ✦ Unclear exactly how number of ticket holders relates to future trends
  - ✦ Tickets have been purchased before any flights, with limited advertising; future purchases may be higher
  - ✦ Some tickets are refundable, some are deposits; possibility to change mind
- ✦ Our survey data says about 7% care about flying early (we asked if they would pay to be in the first 1,000 people to fly)
  - ✦ Baseline = 600
  - ✦ Growth = 1,700
- ✦ If all reservation holders fly, and ticket purchases occur in future at the same level, demand will fall between baseline and growth scenarios
- ✦ Until passengers fly, future behavior cannot be predicted with certainty
  - ✦ Positive reports of flight experiences may increase sales
  - ✦ Negative or unexpected flight experiences could slow sales or trigger requests for refunds





# Market Response to a Change in Price

## COMMERCIAL HUMAN SPACEFLIGHT

Individuals

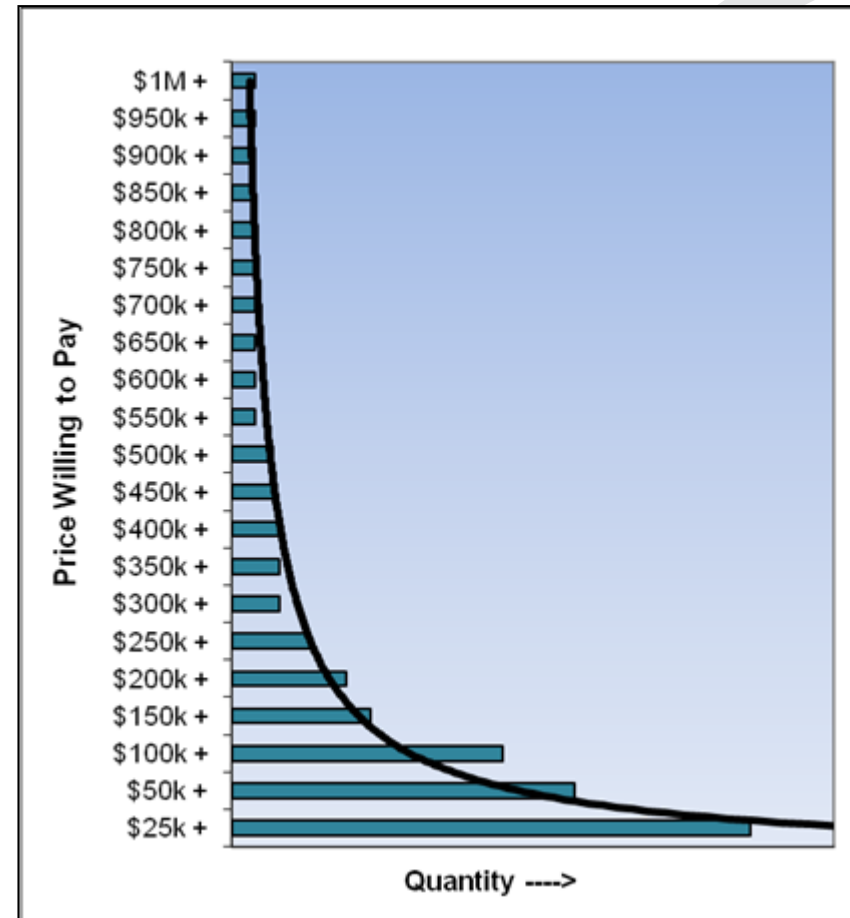
Corporate

Contests and promotions

In-space personnel training

- ✦ If prices decrease, demand increases significantly among high net worth individuals
- ✦ Additional demand (not reflected in curve shown) would result among individuals with lower net worth
- ✦ An increase in price would reduce demand, but comparatively little

**Commercial Human Spaceflight Demand**  
(For individuals with ≥ \$5M net worth. Source: 2012 Tauri Group Space Travel Survey of HNWI's)



# Uncertainties

- ✦ Forecast assumes passengers fly once only and that only 40% of interested passengers today will fly within the next 10 years
  - ✦ Relaxing any of these assumptions increases demand significantly
  - ✦ For example, if 80% of interested passengers fly in the next 10 years, forecast doubles
- ✦ Forecast assesses attitudes and behavior related to an experience that does not yet exist. Flight experience and other factors (awareness, marketing, perceptions of safety, media coverage, and so on) once operations start will shape attitudes and behavior
- ✦ Estimating demand among individuals with less than \$5M in investible assets who will purchase flights using a disproportionate amount of personal assets (“space enthusiasts”)
  - ✦ Estimated at 5% of high net worth demand
  - ✦ Some providers suggest this is a low percentage compared to ticket holders
  - ✦ No public data available on ticket purchase demographics to date
  - ✦ If passengers with a net worth of \$1M rather than \$5M are commonplace, the addressable market increases dramatically
- ✦ Other submarkets
  - ✦ In-space training
    - ✦ Orbital providers and NASA have not indicated interest in using SRVs for astronaut training
    - ✦ Suborbital operators expect that to change once the vehicles are operating and have a proven track record
    - ✦ Excalibur Almaz signed an agreement with XCOR for training, but unclear the extent and timing for such training



# Demand Projection

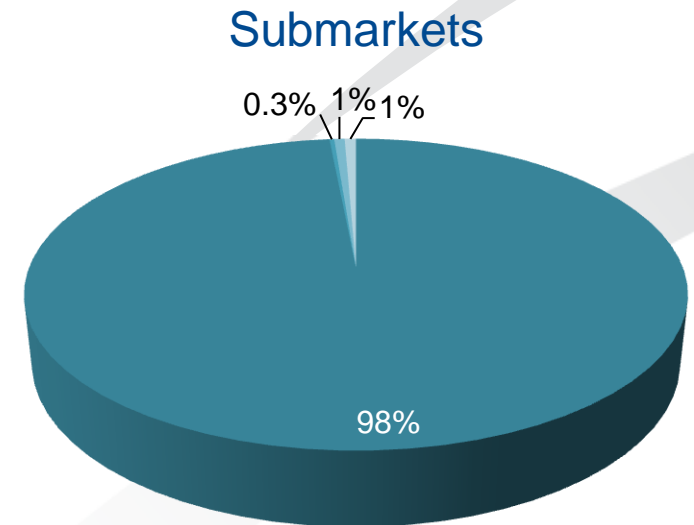
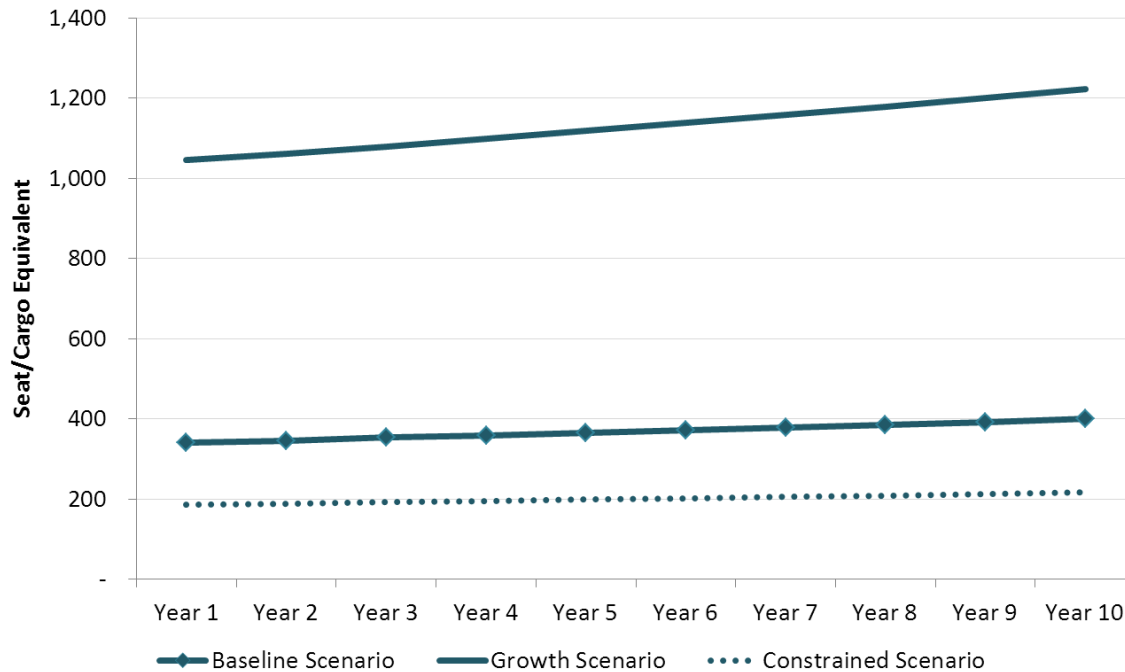
## COMMERCIAL HUMAN SPACEFLIGHT

Individuals

Corporate

Contests and promotions

In-space personnel training



# Basic and Applied Research

## Basic and Applied Research

*Basic and applied research in a number of disciplines, leveraging the unique properties of and access to the space environment and microgravity*

- ✦ Forecast predicts SRVs will attract research spending by non-space agencies, non-profits, universities, NASA, international governments, and commercial firms
- ✦ SRVs can support a wide range of experiments, offering unique capability in four areas
  - ✦ Atmospheric research: access to poorly understood regions of the atmosphere
  - ✦ Suborbital astronomy: high quality IR and UV observations outside the atmosphere
  - ✦ Longitudinal human research: studies of diverse/large populations on frequent flights
  - ✦ Microgravity: unique combination of attributes (duration, human tending, lower cost)
    - ✦ Examples: combustion, crystallization experiments of particles in a charged plasma, interfacial fluid dynamics
    - ✦ Energized researcher community but limited US government funding
- ✦ In order for research to be proposed, funded, and undertaken, researchers must invent an experiment that fits the SRV design niche; takes time
- ✦ Mostly government—commercial firms will experiment to find an application and engage researchers

# Demand Projection

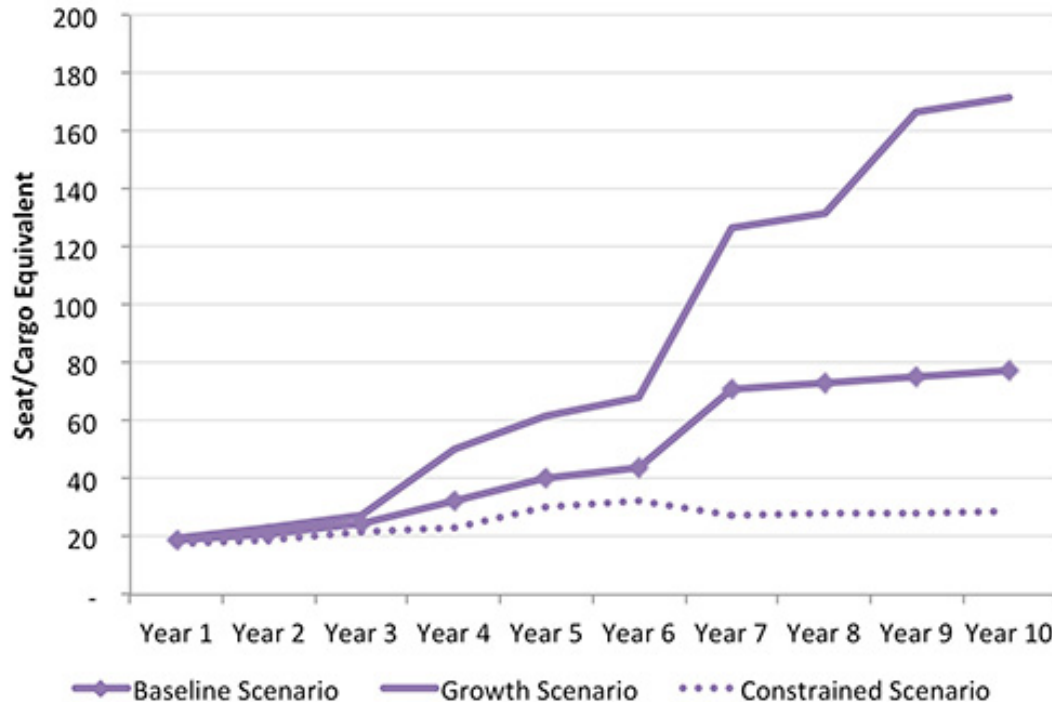
## BASIC AND APPLIED RESEARCH

Biological and physical research

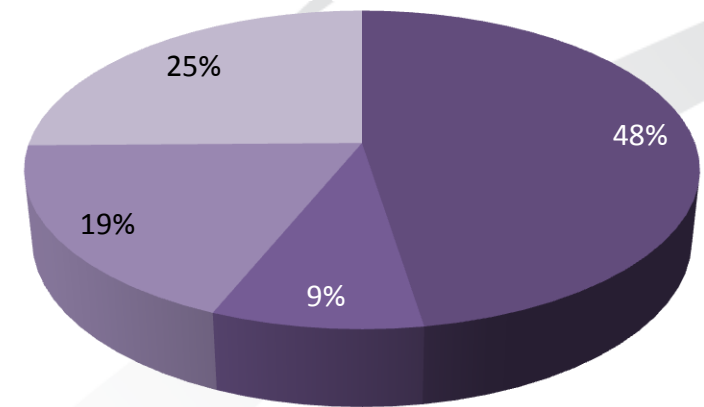
Earth science

Space science

Human research



## Submarkets



Microgravity Baseline

Atmospheric  
Research Baseline

Human Research Baseline

Astronomy Baseline



# Aerospace Technology Test and Demonstration

## Aerospace Technology Test and Demonstration

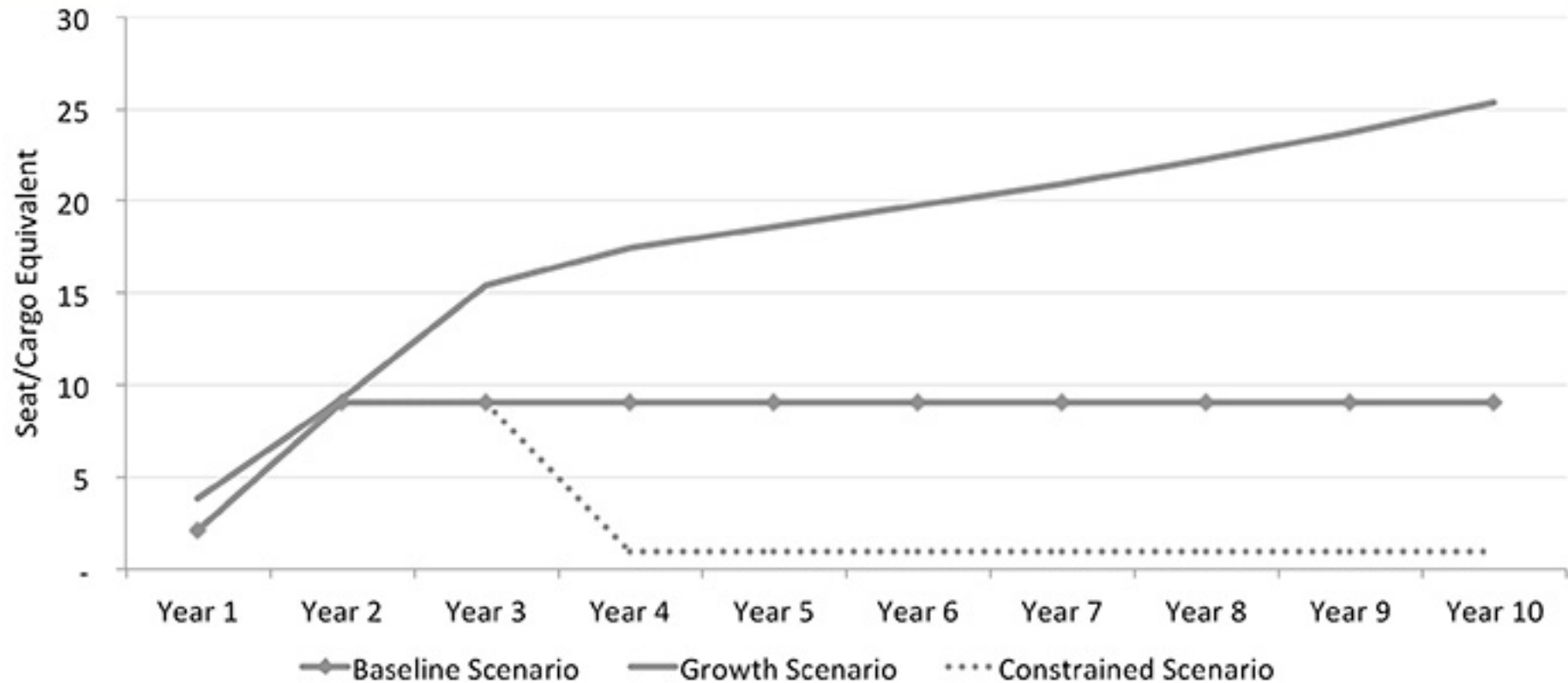
*Aerospace engineering to advance technology maturity or achieve space demonstration, qualification, or certification*

- ✦ SRVs can support most test environments
  - ✦ Best fit
    - ✦ TRL 5, 6, 7 (test in a relevant environment)
    - ✦ Human interfaces, mechanical systems, fluid systems, atmospheric sensors, avionics, and imaging systems
  - ✦ Cost competitive compared to orbital options
  - ✦ Typically higher cost than terrestrial facilities
    - ✦ Advantage: access to space environment
    - ✦ Some terrestrial alternatives may be costlier; for experiment set up
- ✦ Customers are developers of exploration systems (vehicles, habitats, robotics)
  - ✦ NASA and ISS partners likely to be main customers
  - ✦ NASA conducts test and demo on ISS and sounding rockets
  - ✦ About 25% of test, demo experiments from ISS, shuttle, sounding rockets are applicable to SRVs
  - ✦ NASA's Flight Opportunity program has fully covered this demand
  - ✦ Growth shows a three fold increase in tech demo as NASA tests ISS payloads on SRVs first
- ✦ Baseline predicts almost no commercial or DoD demand
- ✦ 15% of the growth scenario is DoD and commercial demand for tech demo
- ✦ Community not clear on how/whether SRV-flown = space qualified
- ✦ Awareness: coordinate with NASA, other agencies to certify the suborbital flight environment for TRL advancement

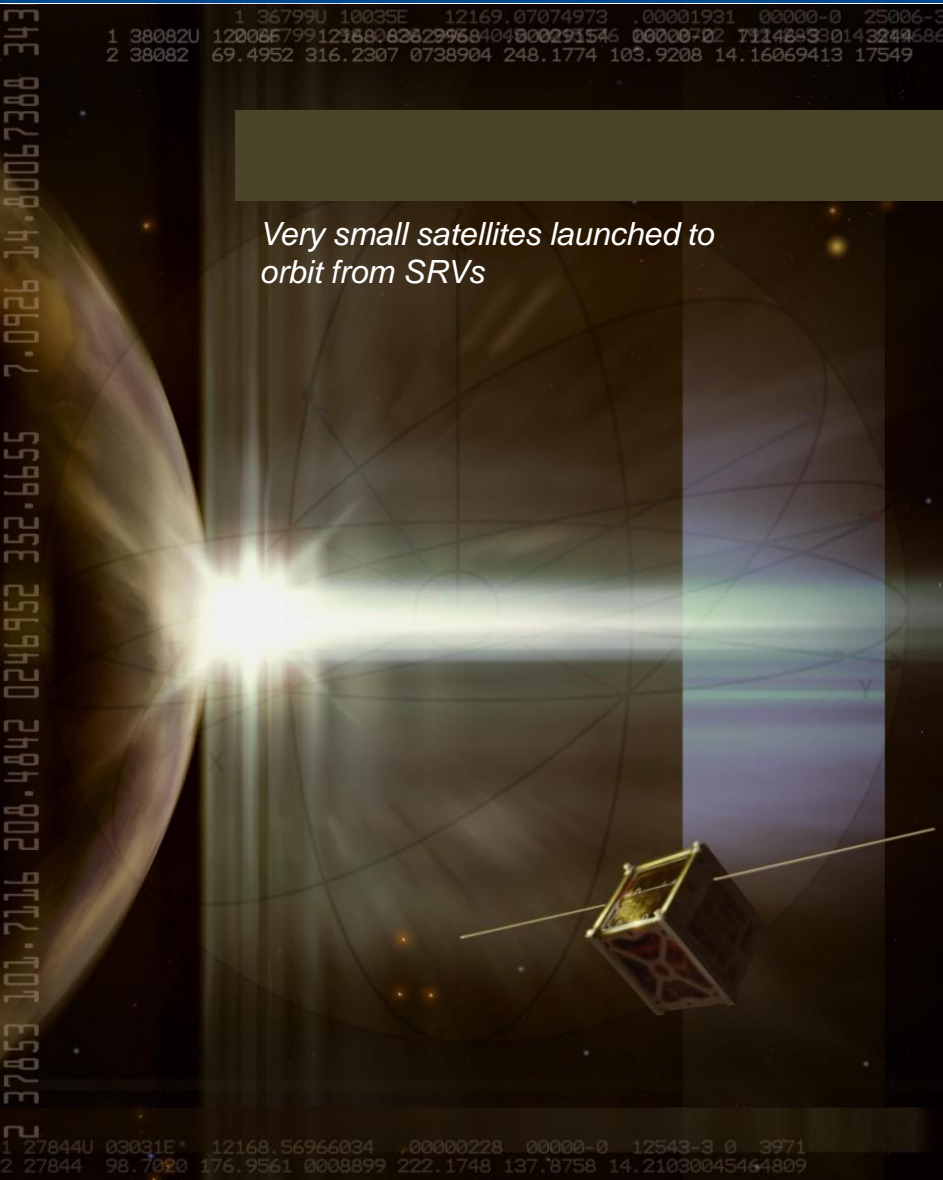
# Demand Projection

## AEROSPACE TECHNOLOGY TEST AND DEMONSTRATION

Demonstrations requiring space/launch environment  
Hardware qualification and test  
Program management training



# Satellite Deployment

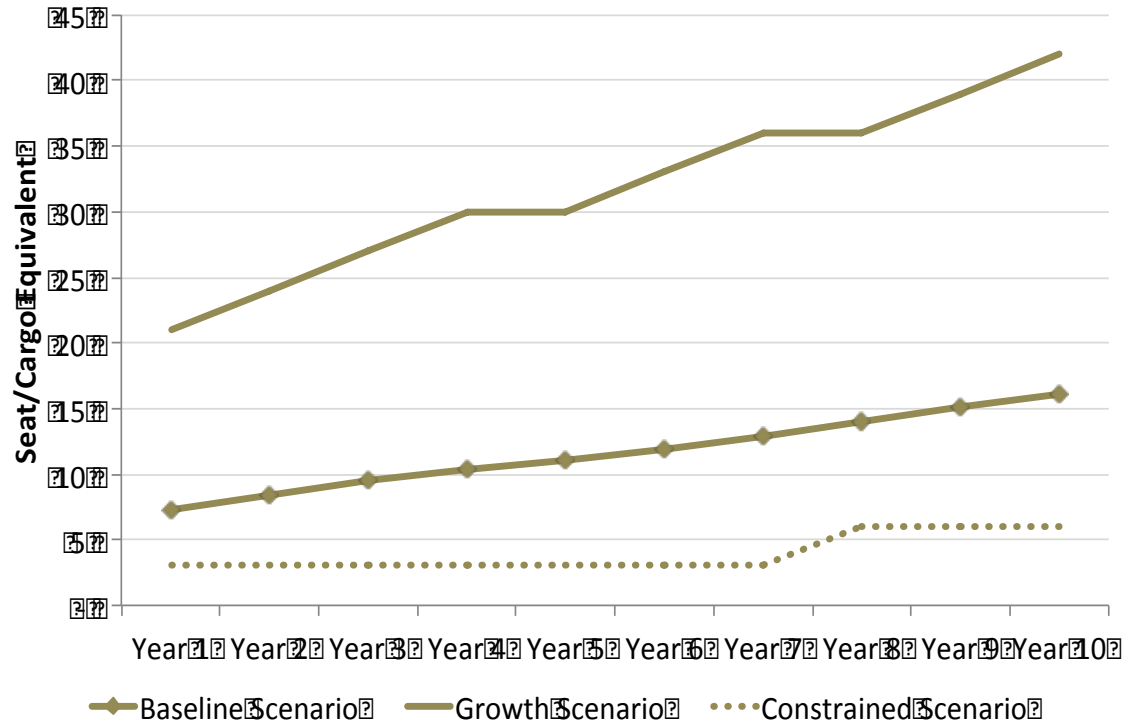


- ✦ SRVs will be price and capability-competitive to launch very small satellites (under 15 kg)
- ✦ About 100 of these satellites annually in the next decade; civil, military, commercial, and education users
- ✦ SRV market share affected by government
  - ✦ DoD plan to develop/use its own vehicles
  - ✦ NASA is working to launch satellites on missions of opportunity
- ✦ SRVs capture about 15% of market in baseline, over 30% in growth scenario
- ✦ Additional upside if government increases use of SRVs over alternatives
- ✦ Uncertainties
  - ✦ Government use
  - ✦ Timeframe for SRV capability
    - ✦ 2017 announced for Lynx Mark III
    - ✦ No dates for other providers
- ✦ Awareness: DoD and NASA was not fully aware of SRV provider capabilities

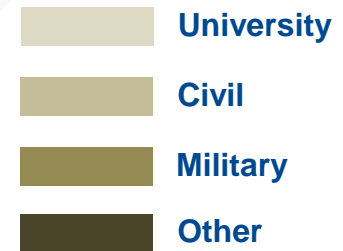
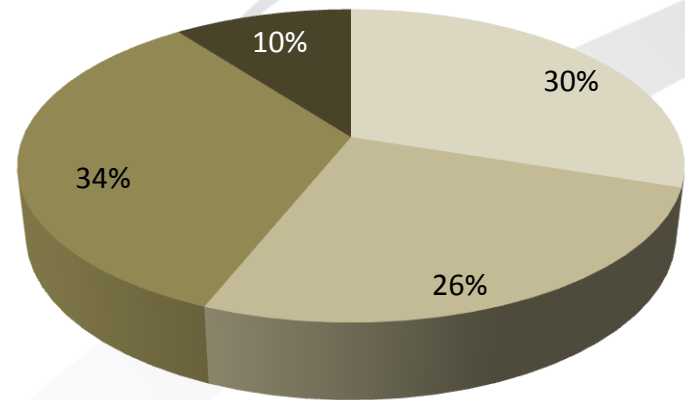


# Demand Projection

SATELLITE DEPLOYMENT  
Very small satellite launch



## Submarkets



# Education

## Education

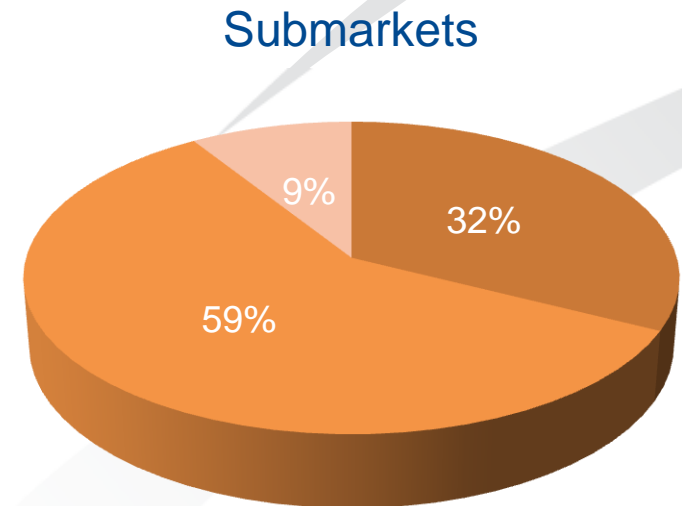
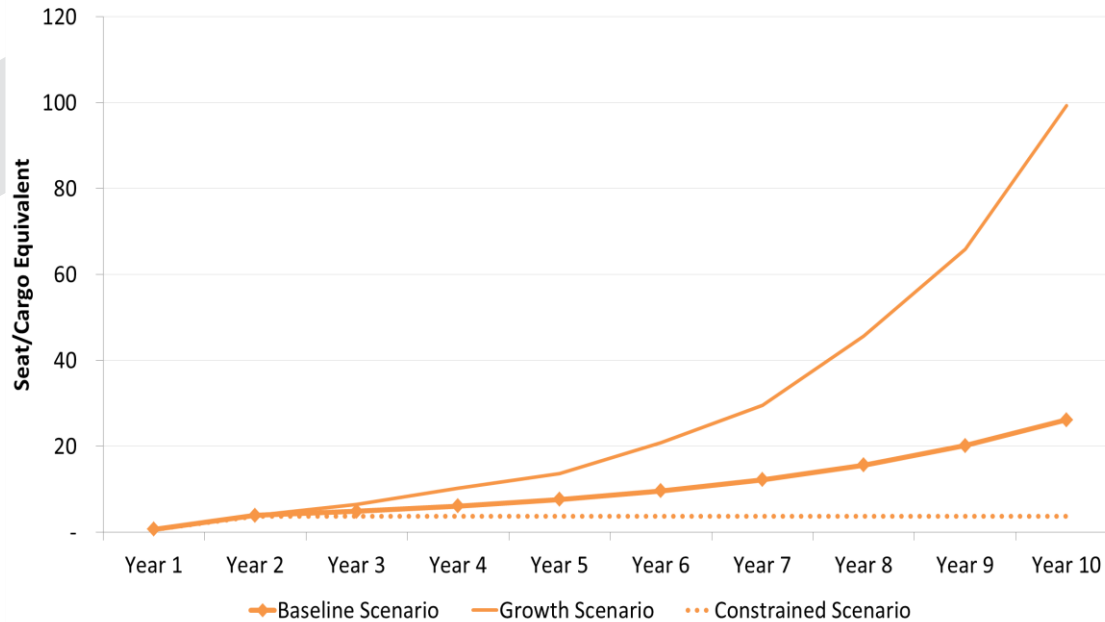
*Flights provide opportunities to K-12 schools, colleges, and universities to increase access to and awareness of space*

- ✦ Forecast predicts 600 (baseline) to 1,400 (growth scenario) K-12 schools
  - ✦ Launch, return of student-built small payloads aligns with STEM goals
    - ✦ High interest from educators if aware of SRVs (few are)
    - ✦ Max budget about \$5K; consistent with estimated SRV prices for cube-sized payload
  - ✦ Similar to successful STEM build projects
    - ✦ FIRST Robotics
    - ✦ Team America Rocketry Challenge
- ✦ Educator flights likely; up to about 15 seats a year by the end of the forecast
  - ✦ Current efforts by not-for-profits
  - ✦ Historical grant funding for teachers on parabolic flights indicates interest
- ✦ University SRV payloads will augment or replace existing student launches at 120 (baseline) to over 200 (growth) universities
- ✦ Awareness:
  - ✦ Easy access for schools
  - ✦ Tie to curricula (Space Florida efforts under way now)



# Demand Projection

**EDUCATION**  
K-12 education  
University educational missions



- University Payloads Baseline
- K-12 Teacher Seats Baseline
- K-12 Payloads Baseline

# Media and Public Relations

## Media and Public Relations

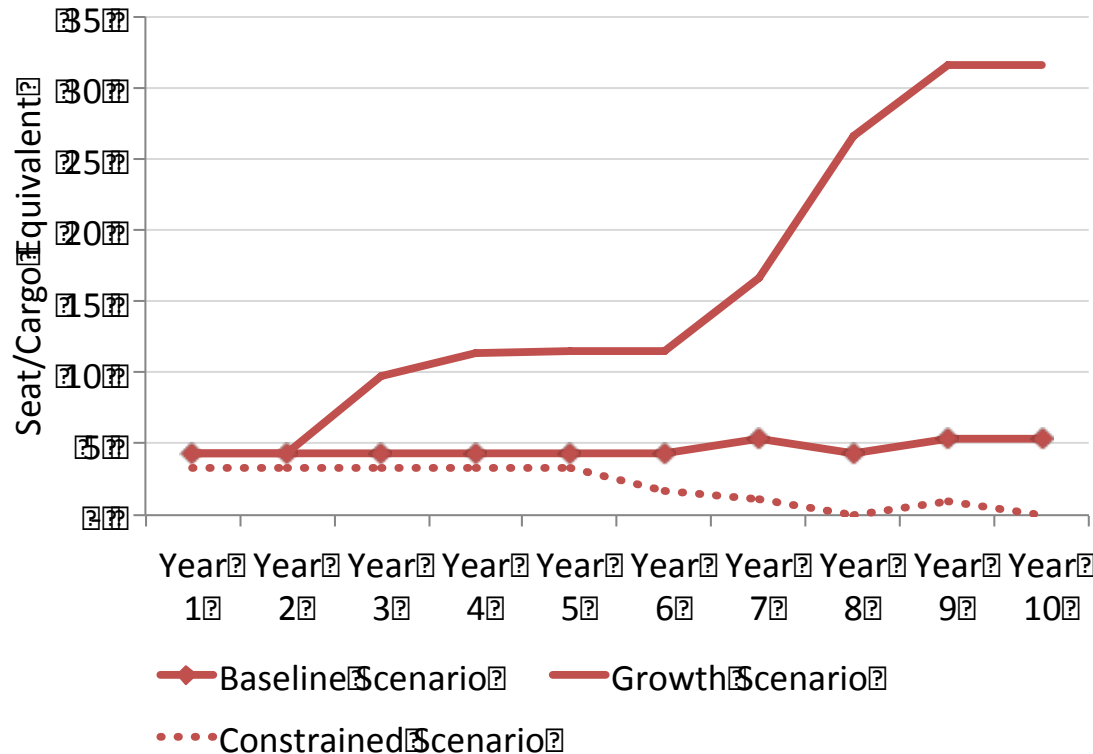
*Using space to promote products, increase brand awareness, or film space-related content*

- ✦ SRVs likely to attract documentaries, reality TV, sponsorships/PR campaigns
  - ✦ Consistent with similar space activity in the past
  - ✦ Baseline predicts 4 to 5 seat/cargo equivalents per year
- ✦ Growth scenario reflects SRV buzz, brand and marketing successes
  - ✦ Larger documentaries, more spending by reality TV shows, bigger ad campaigns generate 30+ seat/cargo equivalents in 10 years
  - ✦ While complexity, cost of filming movies makes demand uncertain, we show about 10 launches for one feature film in growth scenario
- ✦ Uncertainties
  - ✦ Media, public interest – changeable, hard to quantify; could explode, could fade after a few years
  - ✦ Size of activities – a seat? a flight? a series?

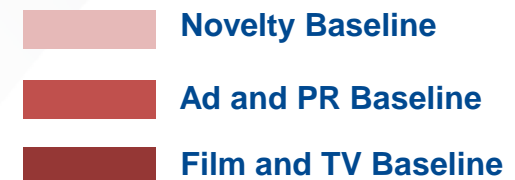
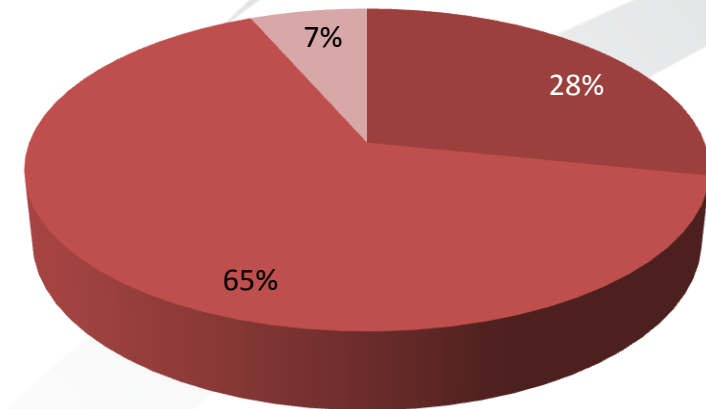
# Demand Projection

## MEDIA AND PUBLIC RELATIONS

Film and television  
Media, advertising, and sponsorship  
Public relations and outreach  
Space novelties and memorabilia



## Submarkets



# Summary of Major Uncertainties

- ✦ Forecast assumptions regarding consumer behavior
- ✦ Commercial interest by industry
- ✦ Changeable perceptions and impact on media and PR demand
- ✦ Research uptake by US agencies that do not traditionally fund space research
- ✦ International government programs to use SRVs
- ✦ NASA and DoD (could be larger users)

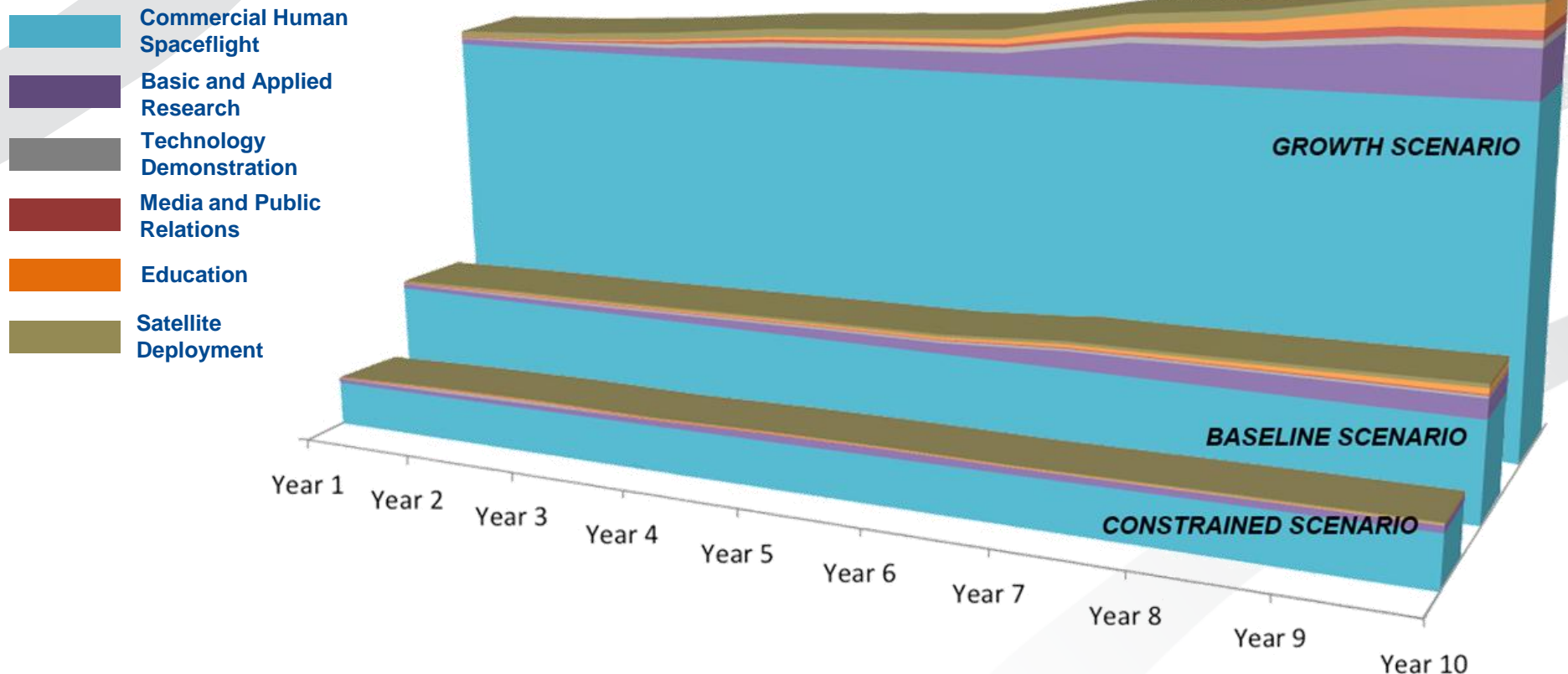


# Integrated Demand Forecast



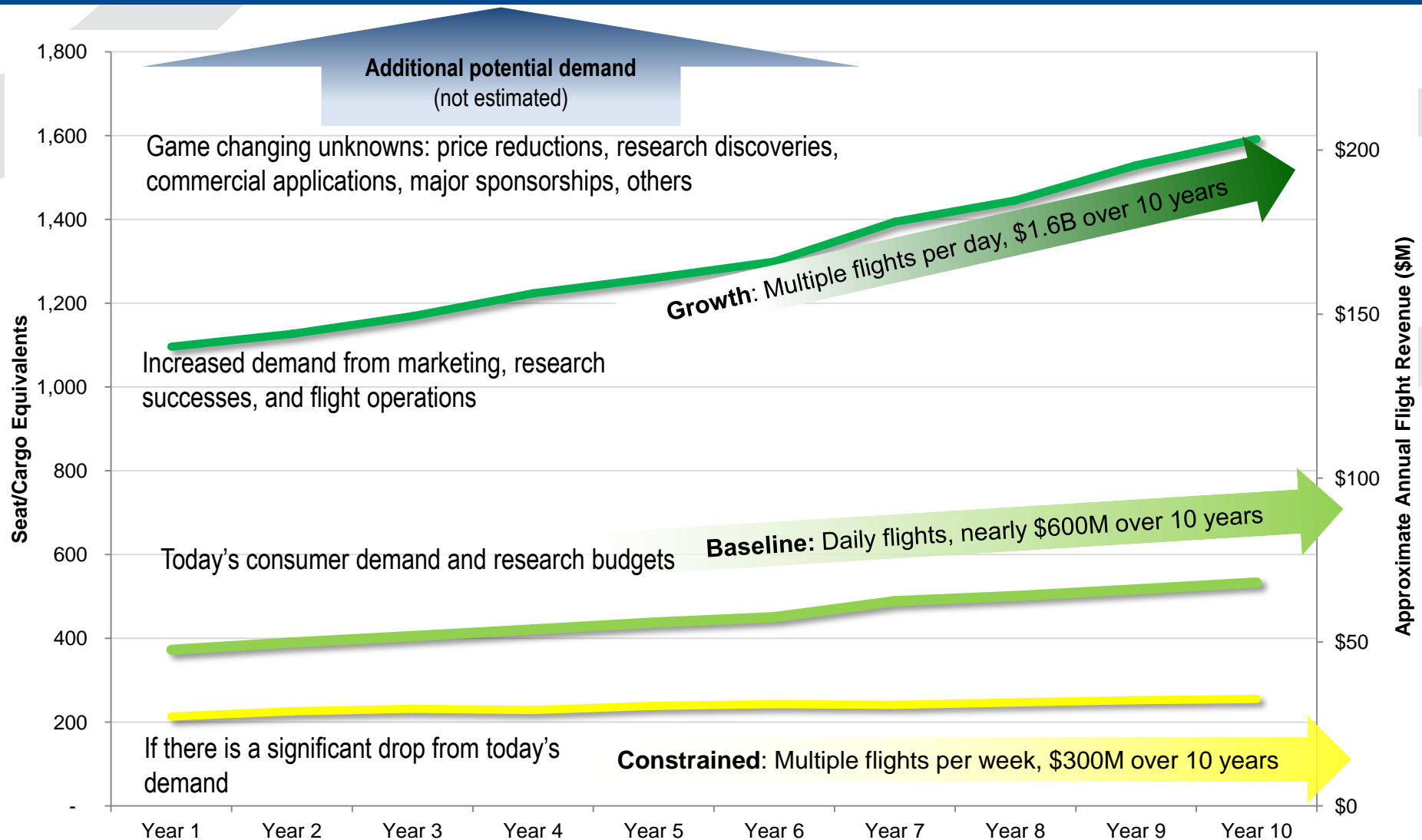


# Demand, by Scenario and Market



Conversion factors: 1 seat/cargo equivalent = 1 seat = 3 $\frac{1}{3}$  lockers

# 10-Year SRV Demand Forecast



# Conclusions

- ✦ Demand for suborbital flight is sustained and appears sufficient to support multiple providers
- ✦ Analysis based on measurable, predictable budgets, consumer interest, and trends
- ✦ Existing demand today, prior to operational human-capable vehicles, baselines hundreds of flights annually, and a new industry generating \$600 million over 10 years
- ✦ Growth scenario (reflecting broader awareness, successful research demonstrations, and increasing consumer interest expected by providers as regular operations approach) predicts more than a thousand passengers and thousands of payloads will seek to fly annually, with multiple daily flights generating \$1.6 billion over 10 years
- ✦ Upside potential associated with gamechanging unknowns (not estimated) such as price reductions, major research discoveries, commercial applications, global brand value and major sponsorships, and new government use such as DoD leverage of SRVs
- ✦ Minimal spending scenario, where consumer demand drops to less than half of today's levels and global research budgets are dramatically reduced, results in demand for multiple flights each week



# Thank You and Contact Information

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